PATENT SPECIFICATION

1,152,342

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DRAWINGS ATTACHED

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Int. Cl.:—B 43 k 8/00

COMPLETE SPECIFICATION

Improvements in and relating to Fountain Pens and Nibs and Ink therefor

We, SCRIPTO INC, of 423 Houston Street, N.E., Atlanta, Georgia, United States of America, a Corporation organised and existing under the laws of the State of Georgia, United States of America, do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to fountain pens and nibs and ink therefor.

The invention provides a fountain pen nib consisting of a rod made from a bundle of a plurality of rows of kinked and twisted filamentary fibers tensioned to extend randomly orientated primarily in a longitudinal direction and bonded together by a hardened resin to form a longitudinally porous structure which will convey ink by capillary action along the nib.

Preferably the tows from which the nib is made each consist of a tow of filaments, preferably polyester filaments, such as are obtained when filaments, spun from one or more groups of spinnerets, are brought together, bulked or textured and combined to form a tow in which the fibers are "randomly orientated primarily in a longitudinal direction." This quoted expression is intended to describe the condition of a body of fibers which are, as a whole, longitudinally aligned in parallel relationship but which have short portions running more or less at random in non-parallel diverging and converging directions.

Suitable bulked polyester fibers are available commercially, as for example "stretch DACRON (Trade Mark) which can be used as received is known to contain approximately 3% by weight of a lubricant to facilitate processing on textile machinery.

The preferred resin is one of the epoxy resins such as those derived from Bisphenol A (4.4′-dihydroxy-diphenyl 2.2′ propane) and epichlorohydrin.

The preferred epoxy resins are generally selected to have a molecular weight of 800 to 1500 and to possess both hydroxy and epoxide functional groups. The above refers to the uncured or raw, meltable, resinous materials and not to the final thermoset resins that are produced upon curing, or hardening, in combination with the filaments during production of the rod.

The curing, or hardening, of the bonding epoxy resins within the fibrous structure can be brought about by means of polyfunctional amines, anhydrides and the like, but with the process to be described, the preferred agent to effect curing of the resin is boron trifluoride. The actual material employed is the complex formed by neutralizing the boron trifluoride with monoethylamine, the active boron trifluoride being released from the complex at the proper time during the process by the application of heat sufficient to decompose the complex and to rapidly effect cure of the resin.

It has been found advantageous to employ a phenolic material, such as Bisphenol A, as an accelerator.

A writing instrument, being a fountain pen of the kind also known as a fiber tip pen, having a porous rigid rod nib and the method of producing the same in accordance with the invention is illustrated on the accompanying drawings, in which:—

Fig. 1 is a longitudinal section of the writing instrument with the cap removed,

Fig. 2 is an enlarged side view of the porous rigid rod nib,

Fig. 3 represents a 15 power photomicrograph of a tow of highly bulked, kinked polyester filaments in a relaxed state,

Fig. 4 represents a 54 power photomicro-

graph of a tow of highly bulked, kinked polyester filaments placed under tension,

Fig. 5 is a very much enlarged partial longitudinal section of the porous rigid rod nib.

Fig. 6 is a transverse section of the porous rigid rod nib showing its structure having substantially uniform interconnecting interstices of capillary dimension.

Fig. 7 shows in side view a dry porous rigid nib in initial contact with the capillary absorbent reservoir element of the writing instrument containing a liquid ink supply,

Fig. 8 is a view corresponding to Fig. 7 and shows the progressive travel of the ink through the porous nib due to the capillary action,

Fig. 9 is a further view corresponding to Figs. 2 and 8 and shows the nib fully saturated with liquid ink, and

Fig. 10 is a Flow Chart illustrating the method of producing the porous rigid rod nib of the present invention.

From Fig. 10, which illustrates the Flow Chart of the process of producing the nib material of the present invention, it will be seen that the process consists of arranging a plurality of continuous kinked and twisted filamentary highly bulked polyester tows in substantially parallel arrangement, from a suitable creel and then placing said parallel tows under a regulated tension and impregnating said tows with a solution of an epoxy resin. A preferred epoxy solution is one containing a resin having a molecular weight of 875, a hydroxyl functionality of 6, and epoxide equivalent weight ranging betwen 450 and 525 in an organic solvent mixture.

The use of a solution serves to insure a uniform application of a limited quantity of the resin binder to the surface of the filaments. The "soaked" tows are pulled vertically upward from the resin solution and passed as a loose bundle through a drying oven where the major portion of the solvents employed to dissolve the resin is removed. The bundle of tows is then pulled through a heated die which effects fusion of the resin and compacts the "stretch" filament material into the desired rod shape. The rod-like structure then passes through an aqueous solution of the catalyst, $BF_3—C_2H_5NH_2$, wherein the capillary structure absorbs the catalyst solution. The rod, saturated with the catalyst solution, then passes through the pre-curing oven. The elevated temperature in the pre-curing oven removes the moisture that was absorbed during the passage through the catalyst bath and releases the boron trifluoride which in turn promotes the cure of the epoxy resin to a rigid matrix. A tension mechanism operates at the base of the curing oven to maintain the rod in a straight configuration as it passes through the oven. The partially cured rod, at this point, is quite strong and can be easily handled. The strength and rigidity at this point permit the rod-like structure to be cut to convenient lengths for post curing to obtain its ultimate strength.

As mentioned previously the preferred epoxy resin has a molecular weight range of about 800 to 1500 and possesses both hydroxyl and epoxy functional groups. The concentration of the resin used is interdependent upon the number of ends of the filament used and upon the diameter of the rod desired. For purposes of illustration it will be assumed that the desired rod size is to be 0.060 inch in diameter. The resin concentration should then be chosen to fall within the range of 2.0 to 10.0 percent by weight. This solution is maintained at ambient temperature.

The number of ends for a production of a 0.060 inch diameter rod will be selected from the range 40 to 60 for the 2×100 denier, 34 filament "Dacron" (Trade Mark) yarn. This solution is maintained at ambient temperature.

The temperature at which the dryer is operated will range between 100°F.—180°F., provided the speed at which the material is passed through the system is held between 7 and 10 inches per minute. It is desirable not to obtain complete dryness of the fibers as they pass through this portion of the system as trace amounts of the solvents aid in lubricating the molten resin-fiber combination as it passes through the die. Too much solvent remaining in the fibers, however, will interfere with proper absorption of the catalyst solution at the next stage of the process. At speeds higher than 10 inches per minute it is desirable to use drier temperatures of up to 220°F. to obtain optimum drying. It should be apparent that the actual temperature required will be dependent upon the construction of the drier as well as upon the rate of passage of the fiber.

The aqueous catalyst solution is maintained at a concentration of about 3 to 6 percent by weight boron trifluoride-ethylamine and it is advantageous, but not entirely necessary, to include small quantities of a wetting agent in the catalyst solution. Amounts up to about 1.0 percent by weight of a non-ionic wetting agent is adequate for proper absorption of the catalyst. A suitable wetting agent is an alkylphenoxy polyethoxyethanol.

The catalyst uptake should be regulated so that the catalyst solution is used at a rate equivalent to 0.1 to 0.3 the rate of depletion of the resin solution, if the concentration of the boron trifluoride complex is in the range listed above. This regulation is obtained by adjusting the amount of wetting agent utilized and by adjusting the degree of drying of the fibers as they pass through the dryer tube. The catalyst solution is maintained at room temperature.

The die (in the case being considered the

die is 0.059 inch in diameter) may be constructed of a number of materials and is conveniently a brass block with an insert of hardened steel. The selection of a hardened steel insert was made because of the ease of obtaining a highly polished, hard wearing surface. The temperature of the die is maintained at 430°F. to 460°F. Below 430°F. the rod produced may not be sufficiently bonded to maintain a cylindrical configuration while passing through the drive mechanism. Above 460°F. it is difficult to maintain continuous operation because at this high die temperature the "Dacron" (Trade Mark) fibers lose strength with the result that the material is frequently pulled part in the die.

The drive mechanism is adjusted to give a flow of material through the system of about 7 to 10 inches per minute. This rate of production is intended to provide a basis for example and is not meant to imply that this is the optimum rate of flow of material through this system.

The pre-curing oven is operated at approximately 300°F. to 450°F. and the residual time of the material in the oven should be of the order of at least 10 to 12 minutes. Under these conditions the rod structure should be sufficiently sturdy to permit cutting to convenient lengths for post curing.

The tension device which maintains the straight configuration of the material as it passes through to pre-curing oven is adjustable so that a very slight "tugging" effect is initiated when any movement (of the rod-like material) other than vertical is detected.

The post curing of the rod, usually cut to approximately the final desired length, is accomplished by heating at 350°F. to 475°F. for periods of 1 to 2 hours. It should be obvious to one cognizant with curing or hardening of epoxy resins that lower temperatures for greater periods of time could be used to effect this post cure. Temperatures significantly higher than the above range will not be beneficial and, in fact, may be detrimental to the structural strength of the final fiber nib.

After post curing the rod-like material may be pointed by dry or wet grinding; for example, with a coarse silicone carbide grinding wheel. Microscopic examinations of the fiber nib structure are shown in Figs. 5 and 6.

It should be noted that the one drive mechanism serves both to pull the rod through the system to a point beyond the die and to push the formed rod throughout the remainder of the system.

As mentioned above, the resin solution used was dissolved in an organic solvent mixture. The solvent mixture used may not be critical, but it has been found that mixtures of solvents containing, in parts by weight:

40—60 parts Xylene
40—60 parts Methyl ethyl ketone
0—10 parts monethyl ether of diethylene glycol

are useful with most epoxy resins of the desired molecular weight range, and in addition, such mixtures serve well to dissolve the additional materials, e.g., bisphenol A, that are also used.

Typical formulations of epoxy resin binder system that are useful:

	Parts by Weight
Xylene	45—48 parts
Methyl ethyl ketone	45—48 parts
Monoethyl ether of diethylene glycol	1—6 parts
Bisphenol A	0.1—0.2 parts
Epoxy resin (average molecular weight of 875, hydroxyl functionally of 6, epoxide equivalent weight of 450—525)	2—4 parts

Typical catalyst solution to be used with the above formulation.

	Parts by Weight
Deionized water	93—87 parts
Boron trifluoride-ethylamine complex	3—6 parts
Alkylphenoxy/polyethoxyethanol	.1—1 parts

Microscopic examinations of the fiber nib structures so prepared as shown in Figs. 5 and 6 show that the resulting structure is uniform in cross section and devoid of any large areas of accumulated resin and is remarkably free of any gross open areas. Sections cut longitudinally from the fiber nib structure show that the "bulked" texture of the original fibers is retained to a degree. This retention of the texture is believed to account in part for the uniformity of ink flow through the nib.

Since the nature of the resin coated "Dacron" (Trade Mark) fibers present in fiber nibs is such that there is a tendency for water to be repelled rather than attracted into the capillary structure, it has been found advantageous to utilize specially prepared inks for use with these nibs.

Typical formulations are:

	Parts by Weight
Vehicle: Water, deionized	100 parts
Salicylic Acid	0.01—0.10 parts
70% Solution of an alkyl phenoxy	0.5—2.5 parts
polyethoxyethanol (wetting agent)	0.1—1.0 parts

To this vehicle are added water soluble dyestuffs; the amount depending upon the intensity and shade required. Suitable dyes include:

	Parts by Weight (pts.)
Blue Fluids	2 to 8 pts. C.I. Acid Blue 93 added to 100 pts. of the above vehicle.
Red Fluids	2 to 8 pts. C.I. Acid Red 73 added to 100 pts. of the above vehicle.
Yellow Fluids	3 to 6 pts. C.I. Acid Yellow 23 added to the above vehicle.
Orange Fluids	4 to 8 pts. of a 1.5/3 mixture of C.I. Yellow 23 and C.I. Acid Red 18 added to the above vehicle.
Green Fluids	4 to 8 pts. of C.I. Acid Green 16 added to the above vehicle.
Purple Fluids	2 to 8 pts. of a 1/1 mixture of C.I. Acid Red 18 and C.I. Acid Blue 93 added to the above vehicle.
Brown Fluids	5 to 10 pts. of a 1/1.5/3 mixture of C.I. Acid Blue 95, C.I. Acid Yellow 23, and C.I. Acid Red 18 added to the above vehicle.
Back Fluids	8 to 12 pts. of a 4/2/3/2 mixture of C.I. Acid Blue 93, C.I. Acid Yellow 23, C.I. Acid Red 18 and C.I. Acid Green 16 added to the above vehicle. or 7 to 10 pts. of a 3/6 mixture of C.I. Acid Blue 93 and C.I. Acid Black 2 added to the above vehicle. or 5 to 9 pts. of a 3/1/0.75/0.5 mixture of C.I. Acid Black 41, C.I. Acid Violet 12, C.I. Acid Orange 7, and C.I. Acid Green 9 added to the above vehicle.

The fiber nib produced by this process has been found to function very well for transferring the above writing or making fluids from a capillary type reservoir. A typical reservoir material is a loosely compacted, cemented, cellulose acetate capillary material similar to that commonly used for cigarette filters. To produce a writing or marking instrument, it is necessary only to contain the capillary material in a suitable pen barrel or holder, allow the writing fluid to be pulled into the reservoir by capillary action, and insert the fiber nib into the pen barrel so that it contacts the filled reservoir, all as shown in Figs. 1, 7, 8 and 9. Alternately, of course, a predetermined quantity of the writing or marking fluid can be forced into the capillary reservoir by any convenient means.

The present invention has been described in detail above for purposes of illustration only, and is not intended to be limited by this description or otherwise, except as defined in the appended claims.

WHAT WE CLAIM IS:—

1. A fountain pen nib consisting of a rod made from a bundle of a plurality of tows of kinked and twisted filamentary fibers tensioned to extend randomly orientated primarily in a longitudinal direction and bonded together by a hardened resin to form a longitudinally porous structure which will convey ink by capillary action along the nib.

2. A fountain pen nib according to claim 1, in which the fibers are polyester filaments.

3. A fountain pen nib according to claim 1 or 2, in which the resin is an epoxy resin.

4. A fountain pen having a nib as claimed in claim 1, 2 or 3 and having a reservoir charged with ink which is an aqueous solution of soluble coloring materials containing a water soluble organic compound having an affinity for the resin-coated surfaces of the fibers of the nib.

5. A fountain pen as claimed in claim 4, in which said water soluble compound is an alkylphenoxy polyethoxyethanol in a concentration of less than 1%.

6. A method of producing a porous substantially rigid rod suitable for a fountain pen nib as claimed in claim 1, 2 or 3, comprising the steps of arranging a plurality of continuous kinked and twisted filamentary highly bulked tows in substantially parallel relation, placing said parallel tows under adjustable tension, sequentially impregnating said tows with a solution of resin, drying said resin impregnated tows to remove the solvents of said resin solution, passing said resin impregnated tows through a heated forming die to fuse the resin and compact the bulked filaments into the desired cross section for said rod, impregnating said porous rod with a catalyst solution required for polymerization of the resin, and curing said catalyst and resin impregnated rod by removing the solvent from said catalyst solution and activating the catalyst to effect polymerization.

7. A method according to claim 6, in which said resin is an epoxy resin having an average molecular weight of 875, a hydroxyl functionality of 6 and epoxide equivalent weight ranging between 450 and 525, the forming die is heated to a temperature ranging between 430°F. to 460°F., and the polymerization catalyst is a solution of a complex of boron trifluoride and monoethylamine in a concentration of 3 to 6% by weight and is activated by heating within the range of 230°F. to 450°F.

8. A method according to claim 6 or 7 and further characterized by cutting said rod into specified lengths.

9. A method according to claim 8 and further characterised by shaping the ends of said lengths into a conical shape.

10. A fountain pen nib or a fountain pen with a nib and charged with ink substantially as described with reference to the accompanying drawings.

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FIG. 1

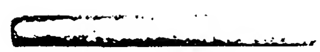

FIG. 2

FIG. 3

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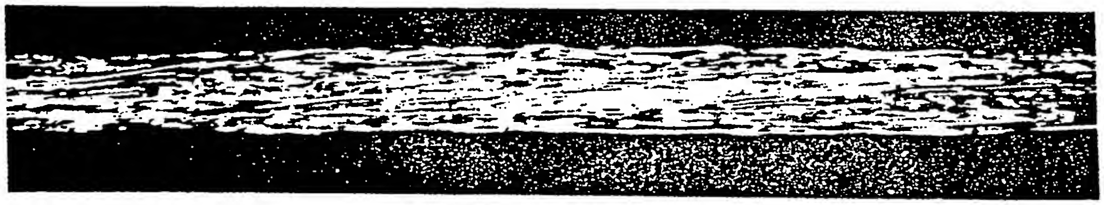

FIG. 4

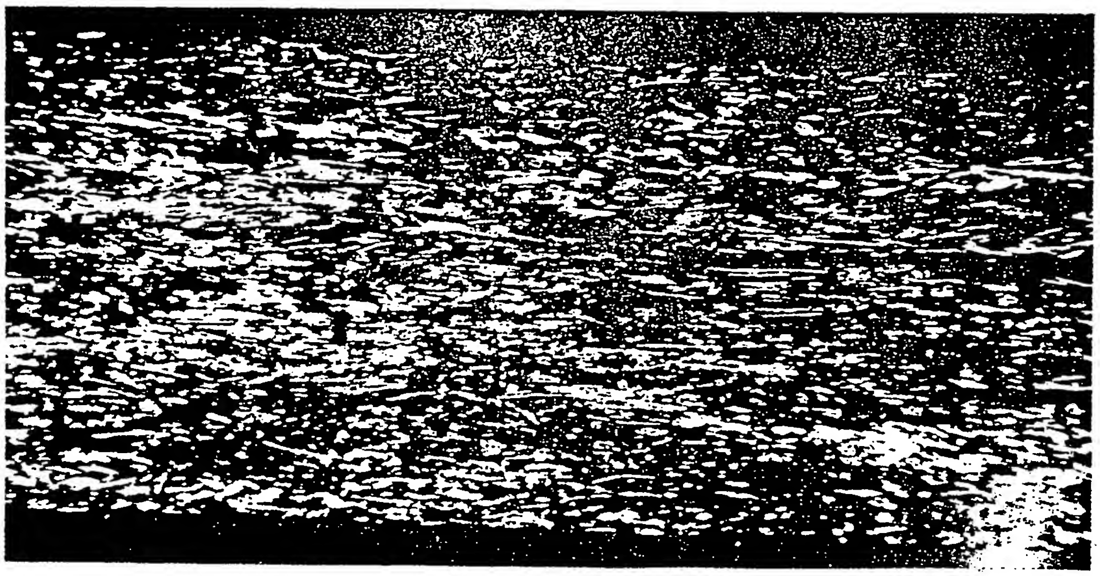

FIG. 5

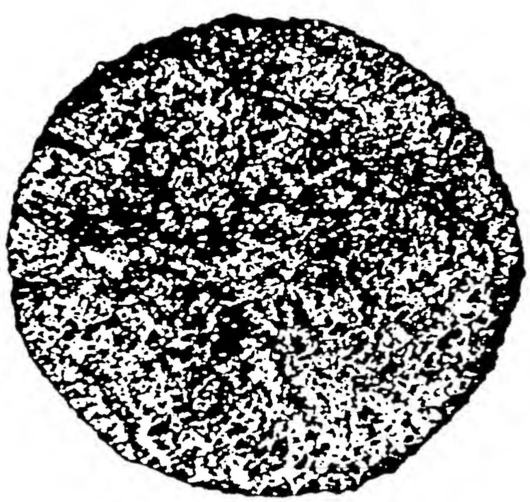

FIG. 6

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4 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

SHEETS 2 & 3

FIG. 7

FIG. 8

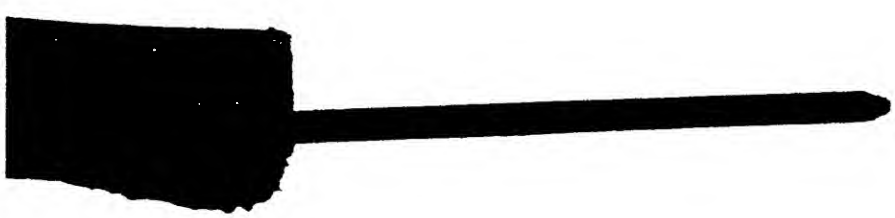


FIG. 9

1,152,342 . COMPLETE SPECIFICATION

4 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

SHEETS 2 & 3

FIG. 4

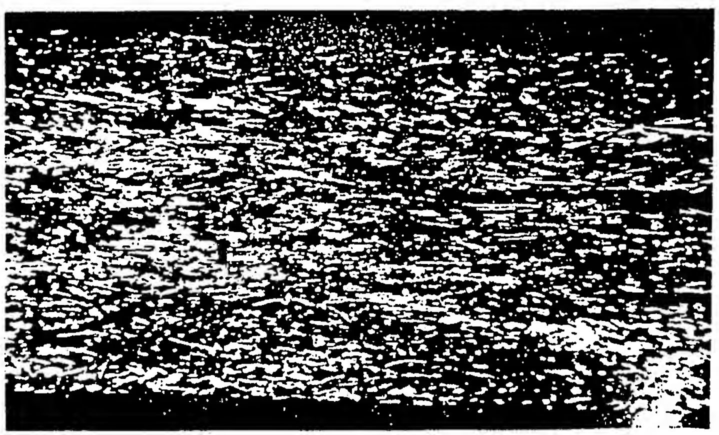
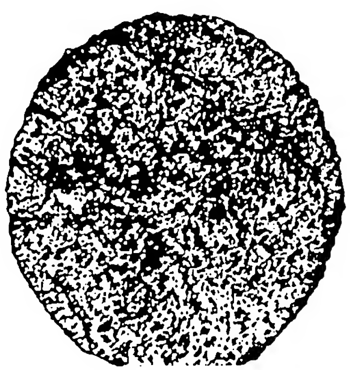


FIG. 5



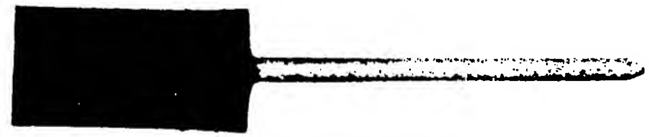
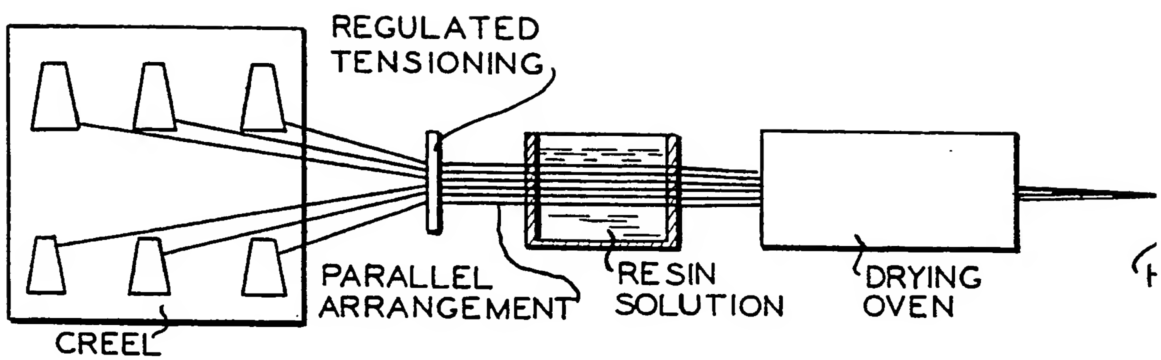


FIG. 7

FIG. 8

FIG. 9


REGULATED
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PARALLEL
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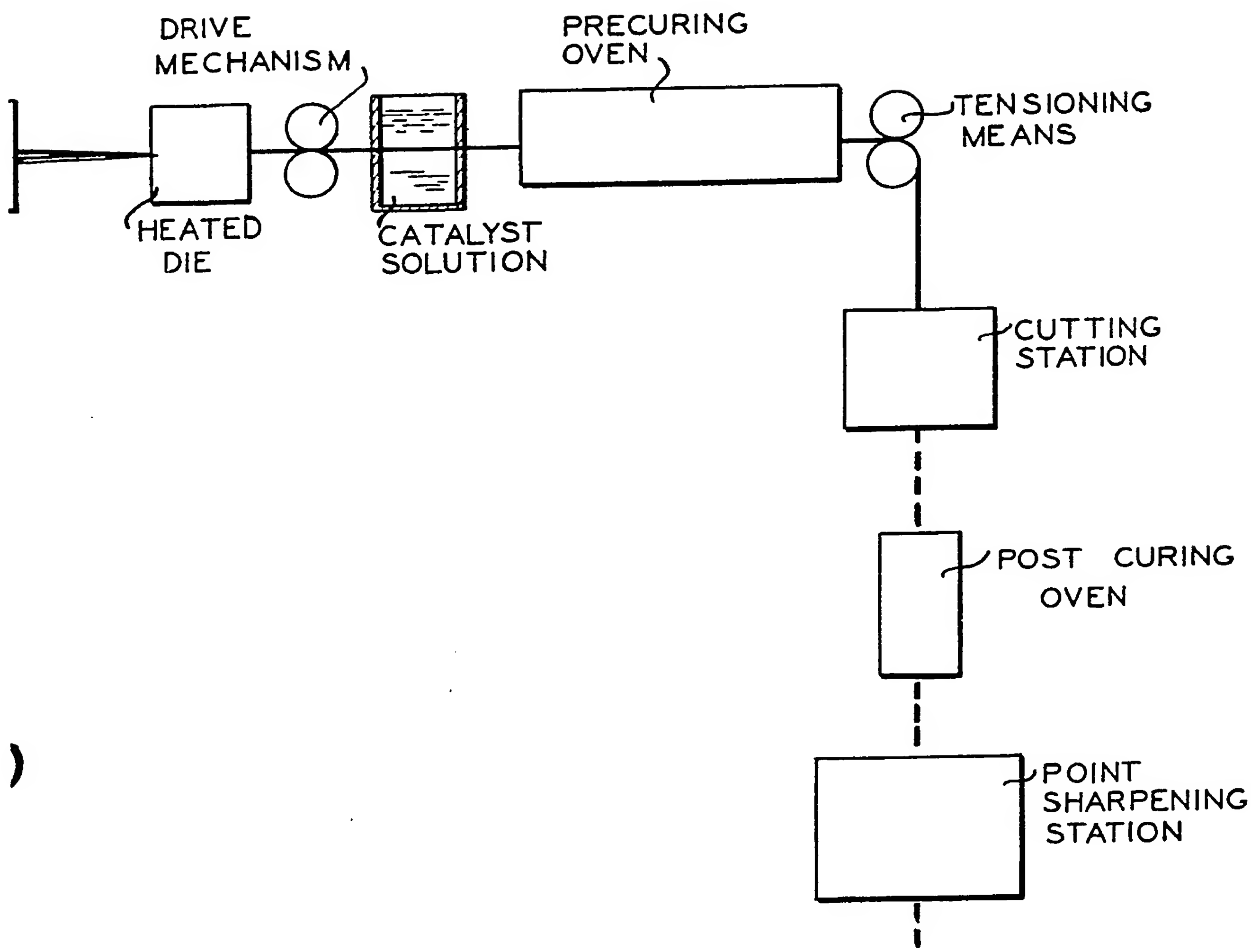
RESIN
SOLUTION
DRYING
OVEN
CREEL

FIG. 10


DRIVE
MECHANISM
PRECURING
OVEN
TENSIONING
MEANS
HEATED
DIE
CATALYST
SOLUTION
CUTTING
STATION
POST CURING
OVEN
POINT
SHARPENING
STATION

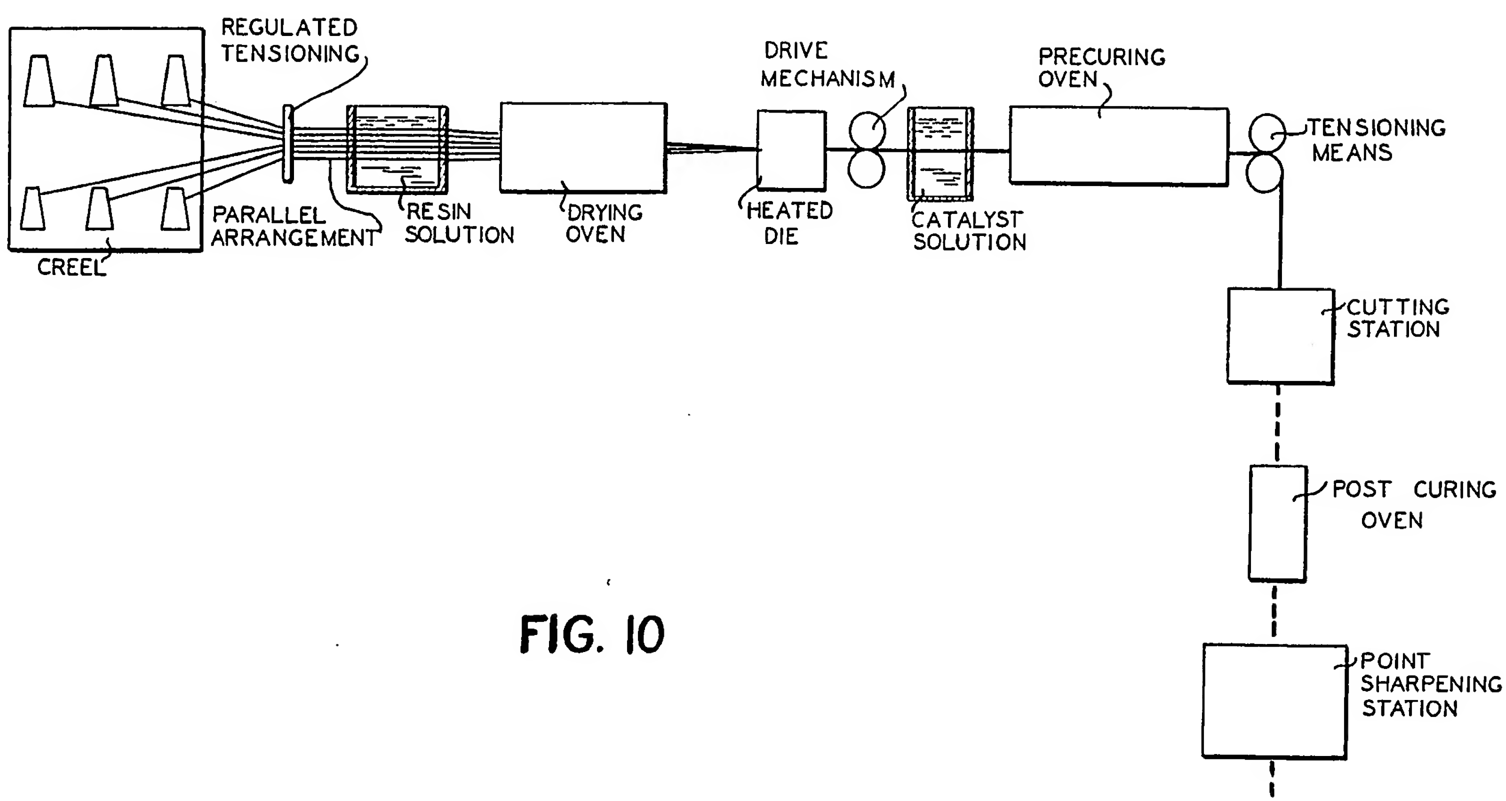

REGULATED TENSIONING
CREEL
PARALLEL ARRANGEMENT
RESIN SOLUTION
DRYING OVEN
DRIVE MECHANISM
HEATED DIE
CATALYST SOLUTION
PRECURING OVEN
TENSIONING MEANS
CUTTING STATION
POST CURING OVEN
POINT SHARPENING STATION

FIG. 10